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GROUND WATER RECHARGE POTENTIAL OF FRESH WATER WETLANDS ON HILTON HEAD ISLAND, SOUTH CAROLINA

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ABSTRACT

Fresh water wetlands on Hilton Head Island have experienced significant degradation over the past few decades. Fifty per cent of the original fresh water wetlands on the island have been either completely destroyed or significantly altered. This fact, plus the declining water levels experienced periodically, have caused much concern over the importance of the wetlands. A major question concerned the role of the wetlands in the recharge of the local ground water aquifer.

The present study was undertaken in order to evaluate the potential of the wetlands for water table recharge. The method of study involved collecting and analyzing geologic samples of the substrate in terms of their hydrologic characteristics. A deep well was drilled to the Tertiary Limestone Aquifer (TLA) in order to acquire geologic samples and provide for sampling and monitoring levels of water in the artesian aquifer. The study commenced in January, 1983 and continued through June, 1984.

Based on the data collected, several tentative conclusions could be reached. The slope of the potentiometric surfaces based on piezometer measurements at 1, 2, and 3 m depths indicated that surface water from the wetland pond occasionally recharged the ground water system. At other times, ground water discharged to the wetland. Occasional recharge from the ponds was also indicated by the vertical pressure gradients observed in piezometer clusters at individual stations. The existence of local recharge to the TLA is not yet evaluated.

INTRODUCTION AND PURPOSE OF STUDY

In recent years there has been increasing interest in the fresh water wetlands on Hilton Head Island. The South Carolina Coastal Council in their Special Area Management Plan for Hilton Head Island (1982) devoted a full chapter to fresh water wetlands. They pointed out that 33 per cent of the island's original fresh water wetlands have been eliminated, and that an additional 20 per cent have been significantly altered. They indicated the generally recognized value of these wetlands for wildlife habitat, as temporary reservoirs for storm drainage, and as natural pollutant treatment systems. A fourth value, their potential importance for ground water recharge is also mentioned. It is to this last point that the present study is directed. The ground water recharge potential of fresh water wetlands is largely unknown.

Related to this question, surface water levels were alarmingly low in the wetlands at the time this study was proposed in the winter of 1981-82. Local interests were concerned about the drying-up of the wetlands. This is a related question because if the wetlands are, in fact, recharging the deeper aquifers and if the aquifers are being drawn down exessively, then there would exist a direct relationship between ground water pumping and wetland surface water level fluctuation. This is a common occurrence in the limestone terraine of Florida, but it is not generally recognized in coastal South Carolina. However, an end to the drought brought wetland surface water levels up to normal elevations by the time the study was begun in the winter of 1982-83. This fact notwithstanding, the basic question remains concerning the relationship of the fresh water wetlands to the water table aquifer, and, secondarily, to the deep limestone aquifer from which the island's water supplies are withdrawn.

The present study is primarily concerned with the first aspect of this question. We concentrated on the surface water levels of the wetlands and their relationship to the water table aquifer. We did not ignore, however, the second part of the above-posed question. In this respect, we have been cooperating with the South Carolina Department of Health and Environmental Control (DHEC) in their larger study of general recharge to the limestone aquifer in the region.

ACKNOWLEDGEMENTS

We would like to express our appreciation to the South Carolina Sea Grant Consortium and the South Carolina Coastal Council for sponsoring the study. Funds were also provided by the Citadel Development Foundation, The Citadel, and the South Carolina Department of Wildlife and Marine Resources. Very important support was provided in the way of encouragement, manpower, and equipment by the South Carolina Water Resources Commission. We want to thank the Nature Conservancy and Hilton Head Plantation for permission to work in the Whooping Crane Pond Preserve. We also thank the Palmetto Dunes Corporation for permission to work in a wetland on their property, which we have named Palmetto Pond. We were assited in various important ways by Pete Stone (DHEC), Roger Jones (Nature Conservancy), and Steve Hopkins (S. C. Wildlife and Marine Resources). Finally, the author wishes to thank his able field assistants, Beti, Coral, and Jimbo, who braved very cold water to assist in this study.

PREVIOUS STUDIES

We discovered that there is a dearth of information concerning (1) the recharge potential from wetlands to the ground water table and, (2) the shallow stratigraphy of Hilton Head Island. We found no previous studies that addressed item (1) directly for Hilton Head Island, or from any other region in the southeastern United States. There have been studies in New England that are pertinent. O'Brien (1977) found that a small wetland underlain by peat acted to recharge the water table aquifer at certain times of the year in Massachusetts.

Similarly, we found no reference that provided detailed information on the shallow (Neogene) stratigraphy of Hilton Head Island. General geologic information on the region is given in Hayes (1979), Spigner and Ransom (1979), and Glowacz and others (1980). General geologic reports include Cooke (1936), Cooke and MacNeil (1952), Colquhoun (1969), and DuBar (1971). An important series of papers relating ground water to geology was published by Siple (1946, 1948, 1956, 1959, 1960, 1967).

GEOGRAPHIC SETTING

Hilton Head Island (Fig. 1) is located at the extreme southwest end of the South Carolina coast at Latitute 32° 10' N. The island is roughly triangular in shape, elongate parallel to the coast, and has an area of 120 km^2 (46.3 mi^2). The island is subequally divided by Broad Creek into a southern and a northern portion. Elevations in the northern portion are generally between 3 and 6 m (10 and 20 ft) msl. Elevations in the southern portion lie mostly below 3 m (10 ft) msl. The terrain is generally flat, with subtle coast-parallel beach ridge traces visible from the air.

The climate is subtropical. Mean annual temperature (Fig. 2) is 18° C (65° F) and ranges from 11° C (52° F) in December to 26° C (79° F) in July. Rainfall averages about 140 cm (55 in) per year, with about 40 per cent of it falling during the summer months.

GEOLOGIC SETTING

Hilton Head Island is a barrier island typical of the southern South Carolina-Georgia section of coast. These barriers tend to be short and stubby due to the relatively high tidal range (over 2 m). The general shape of the coastline of South Carolina and Georgia is concave seaward, producing an embayment referred to as the Georgia Bight. As a result of the existence of the embayment, the continental shelf is wider, tidal range greater, and mean wave heights smaller than those adjacent regions to the north and south.

Hilton Head Island consists of two portions that are geologically discreet based on time of formation (Fig. 1). The bulk of the island, as well as unknown parts that may have subsequently been eroded away on its seaward edge, was formed by beach ridge accretion during the Sangamon interglacial interval (about 120,000 years ago). That period of time was characterized by a sea level stand that was slightly higher than that of the present. There must have been a plentiful sand supply as the island grew to form an extensive beach ridge plain by the addition of successive beach ridges on its seaward margin. This period of growth was ultimately interrupted by a drop in sea level as the Wisconsin glacial period ensued. Sea level was lowered to a position some 100 m or more

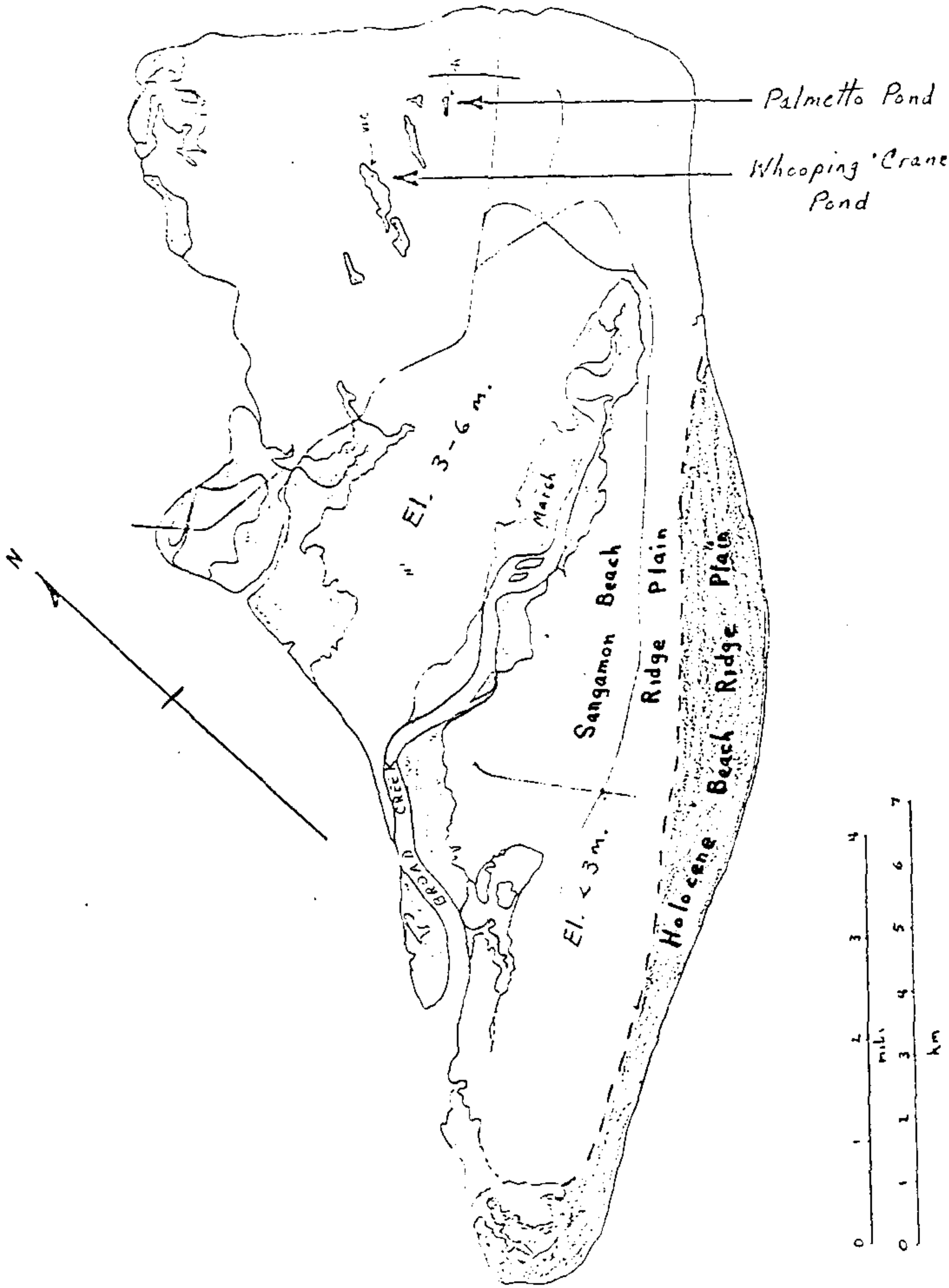


Figure 1. Map of Hilton Head Island showing location of study sites and geomorphology.

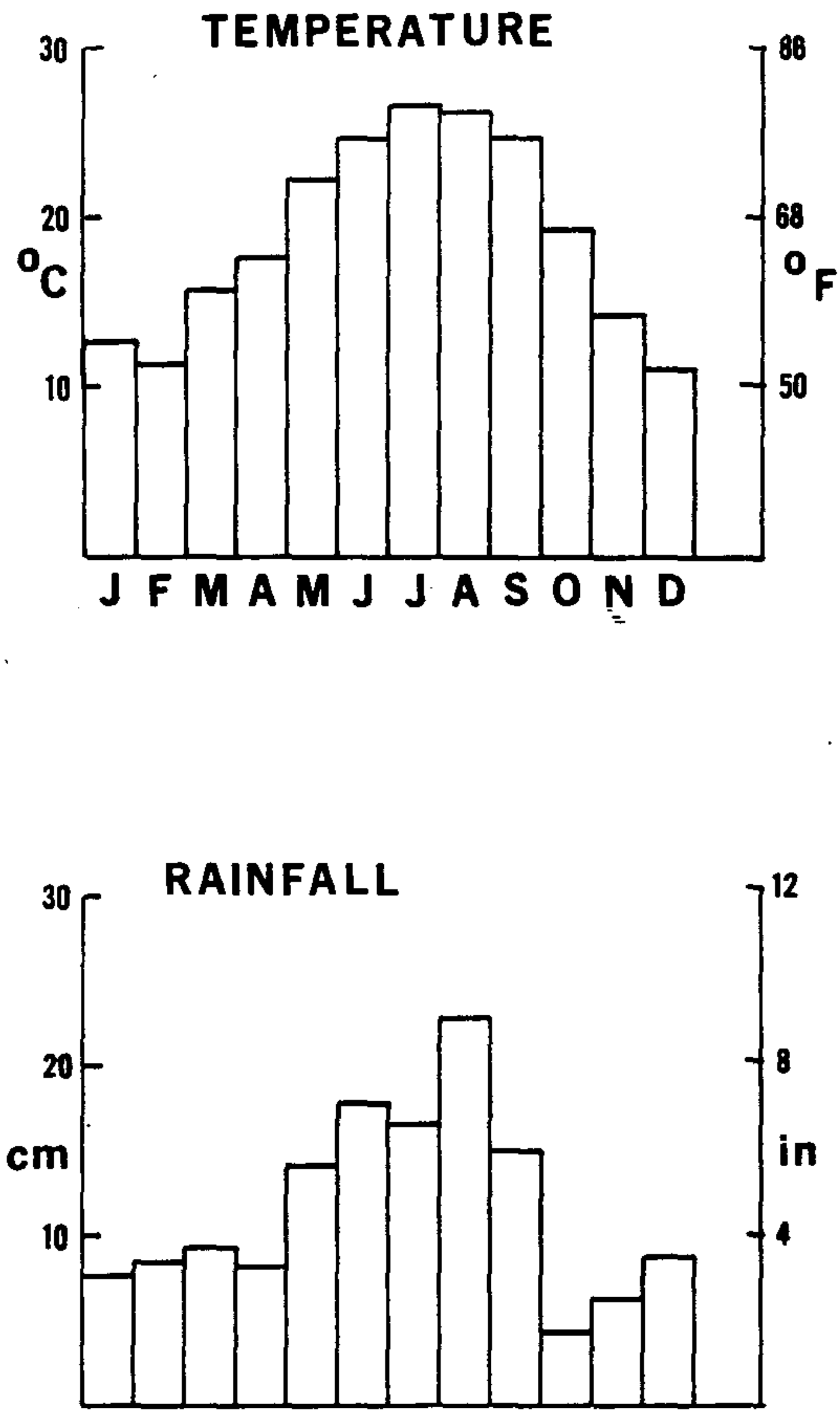


Figure 2. Yearly distribution of temperature and rainfall at Hilton Head Island.

below its present position; hence, the shoreline was approximately 130 km (70 naut. mi.) southeast of its present location. Stated differently, the Sangamon aged portion of Hilton Head Island was located 130 km inland from the coast; hence, it was subject to geomorphic degradation by stream erosion and slope processes typical of inland regions.

Approximately 15-20,000 years ago (the beginning of the Holocene interglacial interval), sea level began to rise once more as the Canadian and other ice sheets began to melt. With the sea level rise, of course, the shoreline was gradually shifted inland...what had been coastal plain became continental shelf. Sea level reached its present position (± 2 m) about 3-4,000 years ago. During the past few thousand years, island growth resumed by additional beach ridge accretion on the seaward margin of the island. These Holocene-aged beach ridges are sharply defined on air photos (being much younger than the Sangamon ridges inland) and are easily distinguished.

The surficial, beach ridge-type sediments that occur on Hilton Head Island are composed of predominantly quartz sand. Fine-grained organic sediments occur in the swales (wetlands) between relict beach ridges. The surficial sands generally extend to a depth of about 10 m. Beneath them there occur deposits of sand, silt, and clay that are commonly heterogeneous both vertically and horizontally. These sediments compose the undifferentiated Miocene, Pliocene, and remaining Pleistocene section and extend to a depth of about 30 m. Below the sand, silt, and clay section lie the limestones of older Tertiary (Paleogene) age which make up the "Tertiary Limestone Aquifer" (TLA). The upper zone of sand, silt, and clay is referred to as the Neogene clastics section and the underlying limestones are referred to as the Paleogene limestone section (equivalent to the TLA).

METHOD OF STUDY

Two fresh water wetland areas were selected for study. The first, Whooping Crane Pond (Fig. 1), is located within the Hilton Head Plantation property. It is part of the Whooping Crane Pond Preserve and is under the management of the South Carolina Nature Conservancy. The study site proper was located on the eastern side of the northern marsh. This location provided good accessibility, and was removed from the bird nesting area located on the western side of the marsh.

A second study site was located in a smaller marsh about 1.6 km (1 mi) east of Whooping Crane Pond. This fresh water wetland is located on property belonging to Palmetto Dunes Corporation; hence, we named it Palmetto Pond (Fig. 1). Because of extensive real estate development, we could not locate a suitable study site on the southern part of the island.

At each of the two study sites, three clusters of standpipe piezometers were installed. Each cluster consisted of three open-ended 1.25" PVC pipes inserted to depths of 1, 2, and 3 m. Stations 1 and 4 (at Whooping Crane and Palmetto Ponds, respectively) were located well out into the marsh in standing water. Stations 2 and 5 were located near the edge of the marsh, which itself is a rather elusive boundary under changing water level conditions. Stations 3 and 6 were located well up onto the adjacent upland where the water table was significantly below ground surface.

At Whooping Crane Pond, we also drilled a 4" well into the Tertiary Limestone Aquifer (TLA) to a depth of 35.8 m (118 ft). This deep well was for the purpose of monitoring water level changes in the TLA and comparing them to changes in the shallow aquifer. We installed automatic water level recorders on the deep well, a shallow water table well, and on the pond surface (at Whooping Crane Pond only). The recorders measured water level position every 6 minutes; hence, they provided a detailed history of water level fluctuations. Water levels were measured periodically in each of the 18 piezometers with an electric circuit-type device. Daily temperature and rainfall information was obtained from the Honey Horn Plantation weather station located 3.5 km (2.2 mi) southwest of Whooping Crane Pond.

All water level measurements and rainfall data were entered into computer files for subsequent anlysis. Various modes of output and analysis are presented in the next section.

The basic question to be addressed by this study concerns the potential for recharge of the ground water table aquifer by the fresh water wetland surface waters. In order to evaluate this potential, we assumed that water would respond to gravity and pressure; that is, it would flow downhill and/or from regions of high pressure to regions of low pressure. By comparing water levels both laterally and vertically among the various piezometers, directions of potential ground water flow can be determined.

Sediment samples were collected at each wetland site with a Dutch Gouge sampler. Also, samples of cuttings were collected at each 10-foot interval from the deep well drilled. Additional information regarding the stratigraphy is provided by various geophysical logs of the deep well. A driller's log was provided by DHEC for the deep well that they drilled in the same area at the Whooping Crane Pond site.

Geologic and hydrologic date were supplemented by information obtained from various published reports and from personal communications with several experts in this field. These sources are referenced where appropriate.

DISCUSSION OF DATA

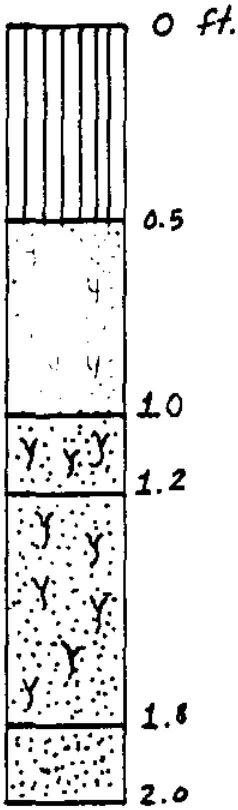
Sediment Samples

Core samples of the wetlands peat deposits were collected at each site. They were examined microscopically and the results are illustrated in Fig. 3. Though a comprehensive study of the sedimentology of the wetlands was beyond the scope of the study, and it is not known to what extent the cores collected are representative of wetlands in general, some important observations can be made. There is a surprising amount of quartz sand in the peat samples. At both sites, the percentage of sand increases rapidly with depth from 1-5 per cent at the upper surface to over 50 per cent at 30 cm (1 ft.). At 60 cm (2 ft.) the sediment is an unconsolidated sand with minor amounts of organic and iron cement. These observations agree with the findings of Otte (unpublished report, 1982), who made stratigraphic cross-sections across Whooping Crane Pond. He found only 30 cm (1 ft.) or less of root mat or peat, underlain by "peaty sand".

The significance of the high sand percentage is that it causes the sediment to possess relatively high permeability. Therefore, water can flow vertically from substrate to pond and from pond to substrate. The hydrologic implications are significant to the present study. If this vertical permeability did not exist, there would be no possibility of either recharge or discharge through the wetland bottom. The nature of the bottom permits the flow of water through it and, hence, recharge and discharge are possible.

Cuttings samples were collected from the deep well that was drilled to the Tertiary Limestone Aquifer (TLA). These samples were examined

Whooping Crane Pond Core



0.0 - 0.1 ft: root mat; fibrous peat; dark brown; high inter- and intragranular porosity; sand, 2%, fine (very fine to fine), subangular.

0.1 - 0.5 ft: peat; dark brown; high inter- and intragranular porosity; sand 10%, fine (very fine to fine), subangular.

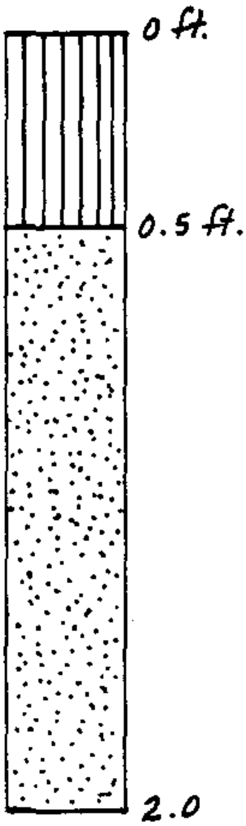
0.5 - 1.0 ft: sand; clear, quartz; high intergranular porosity; fine (very fine to fine), subangular; poorly indurated, organic cement; 30% organics; plant fragments.

1.0 - 1.2 ft: as above.

1.2 - 1.8 ft: sand; clear, quartz, fine (very fine to fine), subangular; high intergranular porosity; poorly indurated, organic and iron oxide cement; 20% organics.

1.8 - 2.0 ft: sand; clear, quartz, fine (very fine to fine), subangular; high intergranular porosity; poorly indurated, organic and iron oxide cement; 5% organics.

Palmetto Pond Core



0.0 - 0.5 ft: root mat and fibrous peat; dark brown; high inter- and intragranular porosity; non-indurated; sand, 5%, fine (very fine to fine), subangular.

0.5 - 2.0 ft: sand; clear, quartz; fine, subangular; high intergranular porosity; non-indurated; 1% organics.

Note - An extremely tough sand layer was encountered while installing standpipe piezometers between 1.5 and 2.5 m. Washings were clean, quartz sand, but cement may have been washed out and may cause decreased porosity and permeability through that interval.

Figure 3. Descriptions of sediment core samples from Hilton Head wetlands.

microscopically and their sedimentologic attributes described as illustrated in Fig. 4. Also shown are the gamma log data and descriptions from the DHEC well drilled nearby (less than 100 m distant). There are some areas of agreement and some of disagreement between the logs of our well and that of DHEC. It is assumed that both are reasonably accurate and that they represent lateral variation in the nature of the underlying sediment (i.e. facies change). Lateral variation appears to be common in the Neogene section on Hilton Head (Ransom, Personal Communication, 1983). [Some of the minor discrepancies may be due to poor sample quality rather than representing actual differences.]

The section revealed by our deep well indicates that there are no significant clay layers that would inhibit the vertical flow of water between the surface and the TLA. That is, local recharge of the TLA from the Neogene section above is probably occurring due to the absence of continuous clay confining layer that would prevent such vertical movement. In summary, the geologic conditions at Whooping Crane Pond are such that there is nothing that should prevent local recharge of the TLA from occurring.

Water Level Measurements

Water levels were periodically measured manually in 18 standpipe piezometers, 9 at each wetland site. The 9 at each site were located as indicated in Fig. 5. Water levels were measured weekly initially. The sampling interval was increased later in the study. In addition, automatic recorders were installed at Whooping Crane Pond that recorded water level every 6 minutes. Recorders monitored water levels on (1) the pond surface, (2) the water table surface near the edge of the pond, and (3) the potentiometric head in the TLA. Comparison of the periodic readings to the continuous records provided a more detailed history of water level fluctuation in the Whooping Crane Pond wetland and, by analogy, in the Palmetto Pond wetland. The manual measurements began January 15 in Whooping Crane Pond and on February 19 in Palmetto Pond. The recorders were installed March 10 and 11, 1983. Measuring terminated June 30, 1984.

The manually measured water level data provides information on both horizontal and vertical gradients of potentiometric surfaces. Figure 6 illustrates horizontal gradients at Whooping Crane Pond.

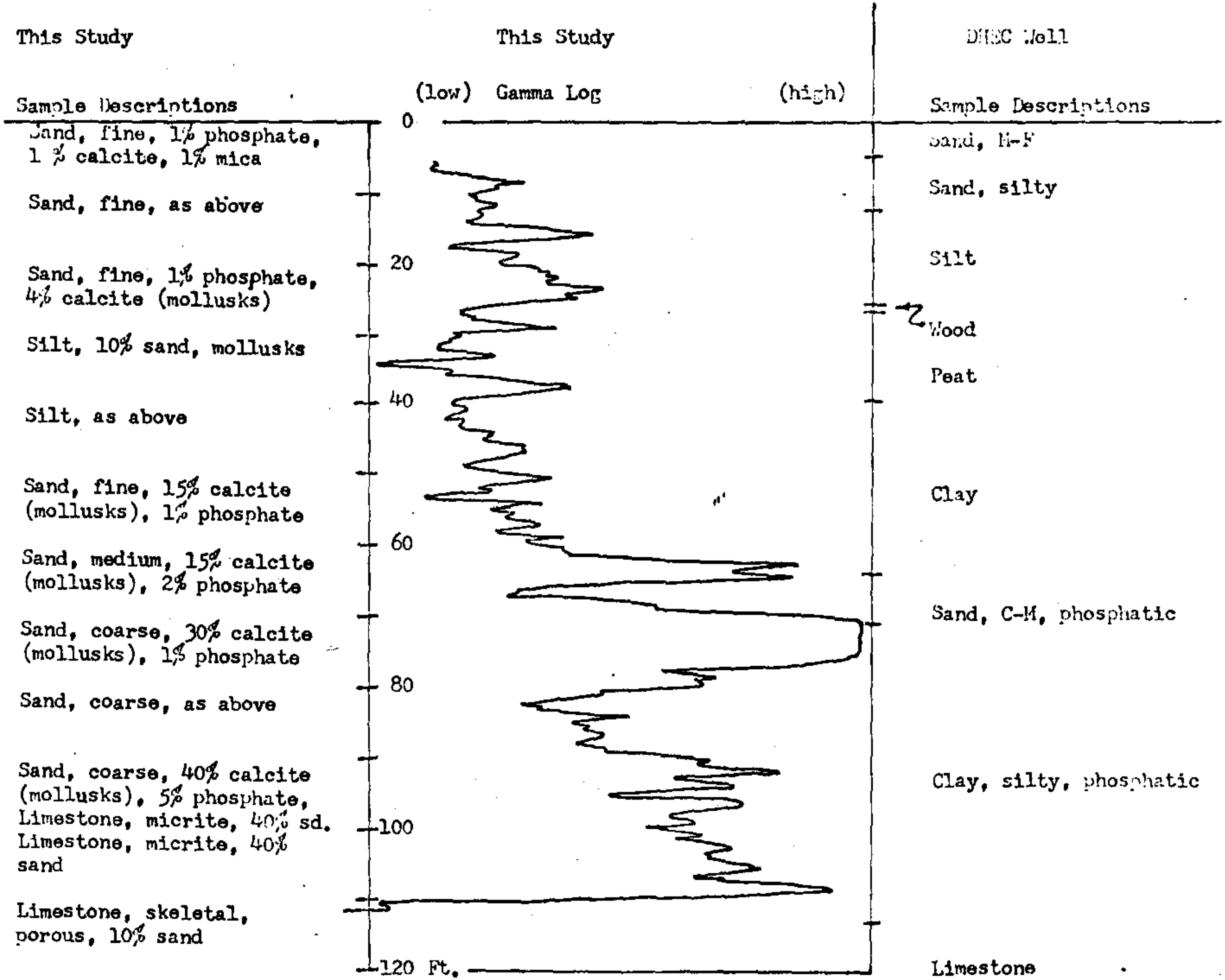


Figure 4. Descriptions of samples from well at Whooping Crane Pond, gamma log, and DHEC well.

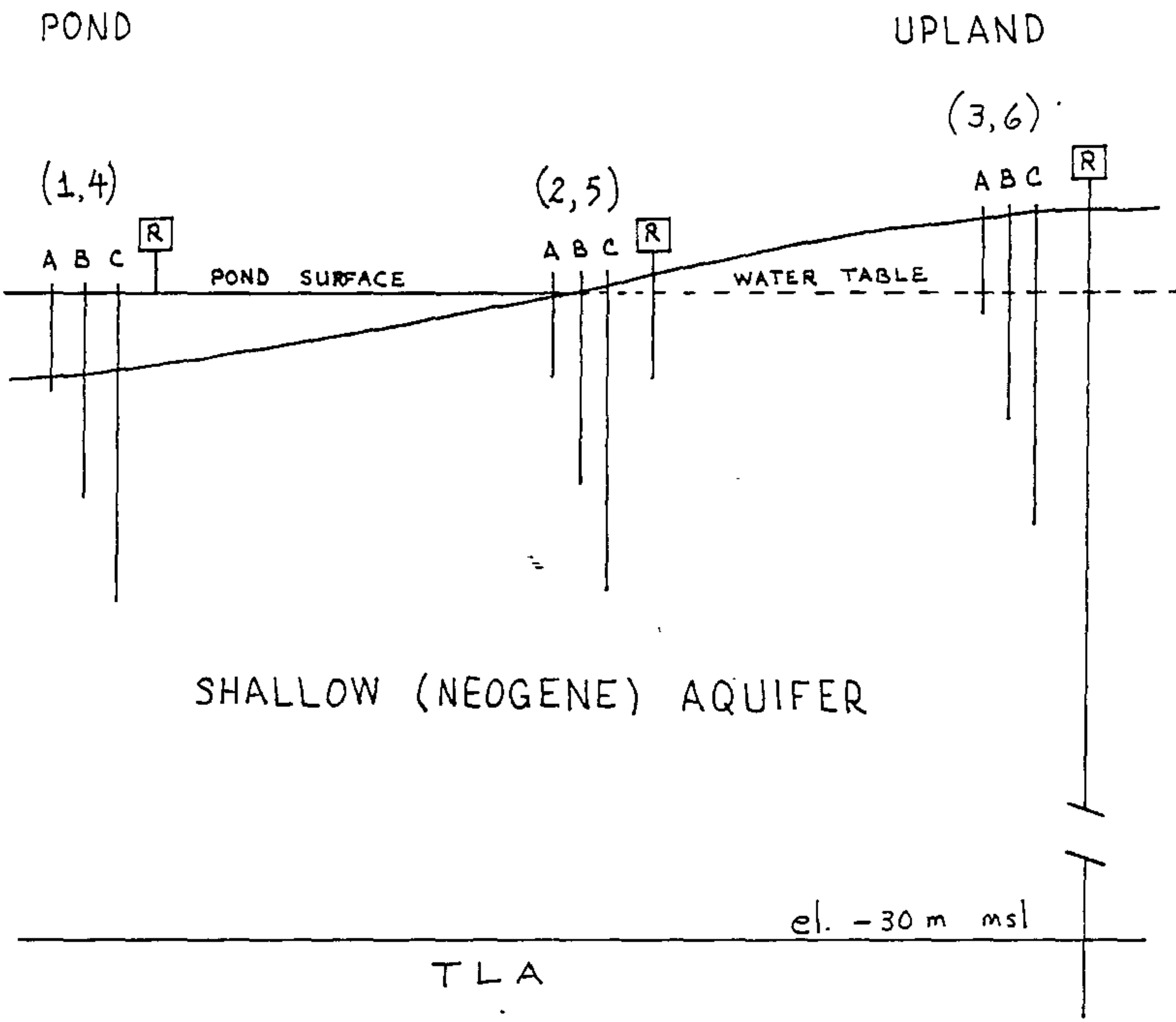


Figure 5. Diagram of piezometer and recorder installation at Whooping Crane Pond site.

Figure 6A shows water level versus time for data from the 1 meter piezometer. A comparison of the position of the solid line (the pond station) to the dashed line (the upland station) reveals the slope of the water table. If the solid line is higher than the dashed line, the water table slopes away from the pond and recharge is indicated. If the dashed line is higher than the solid line, discharge from the water table to the pond is indicated. It can be seen that periods of both recharge and discharge are indicated. The interval of discharge between days 180 and 360 are not as significant as it may appear. Many of these readings are of a dry bottom, the water level having dropped below the bottom of the pipe.

Figure 6B and 6C show the data from the 2 and 3 meter piezometers, respectively. Similarly interpreted, they indicate a dominance of recharge conditions throughout the year.

From these interpretations, it can be concluded that the wetlands do act as areas of ground water recharge at times. In fact, indications are that recharge is predominant over discharge.

Figure 7A-C illustrates the water level data from Palmetto Pond. The situation here appears quite different. The data from the 1 meter piezometer (Fig. 7A) again reflects mostly dry hole conditions. The first 150 days may be valid, in which case the situation is one of recharge being dominant. Figure 7B and 7C show water levels in the 2 and 3 meter piezometers. These plots look suspect. The upland water levels are as much as 1 meter higher than the pond edge and the pond stations. As the stations are only a few tens of meters apart laterally, the indicated horizontal gradient is abnormally high. It shows up in two different piezometers; hence it may be assumed that it reflects a natural condition and not some factor related to the installation. There may be some type of permeability barrier between the upland station and the others, though the geologic conditions that would create such a barrier is difficult to conceive. If, on the other hand, we discard the data from the upland station, the pond level is consistently higher than the pond edge, indicating recharge. The latter interpretation is considered more probable based on the unusual appearance of the upland data and based on the data from Whooping Crane Pond.

Though the data from Palmetto Pond is somewhat ambiguous, there is an indication that recharge conditions may occur at times. Coupled

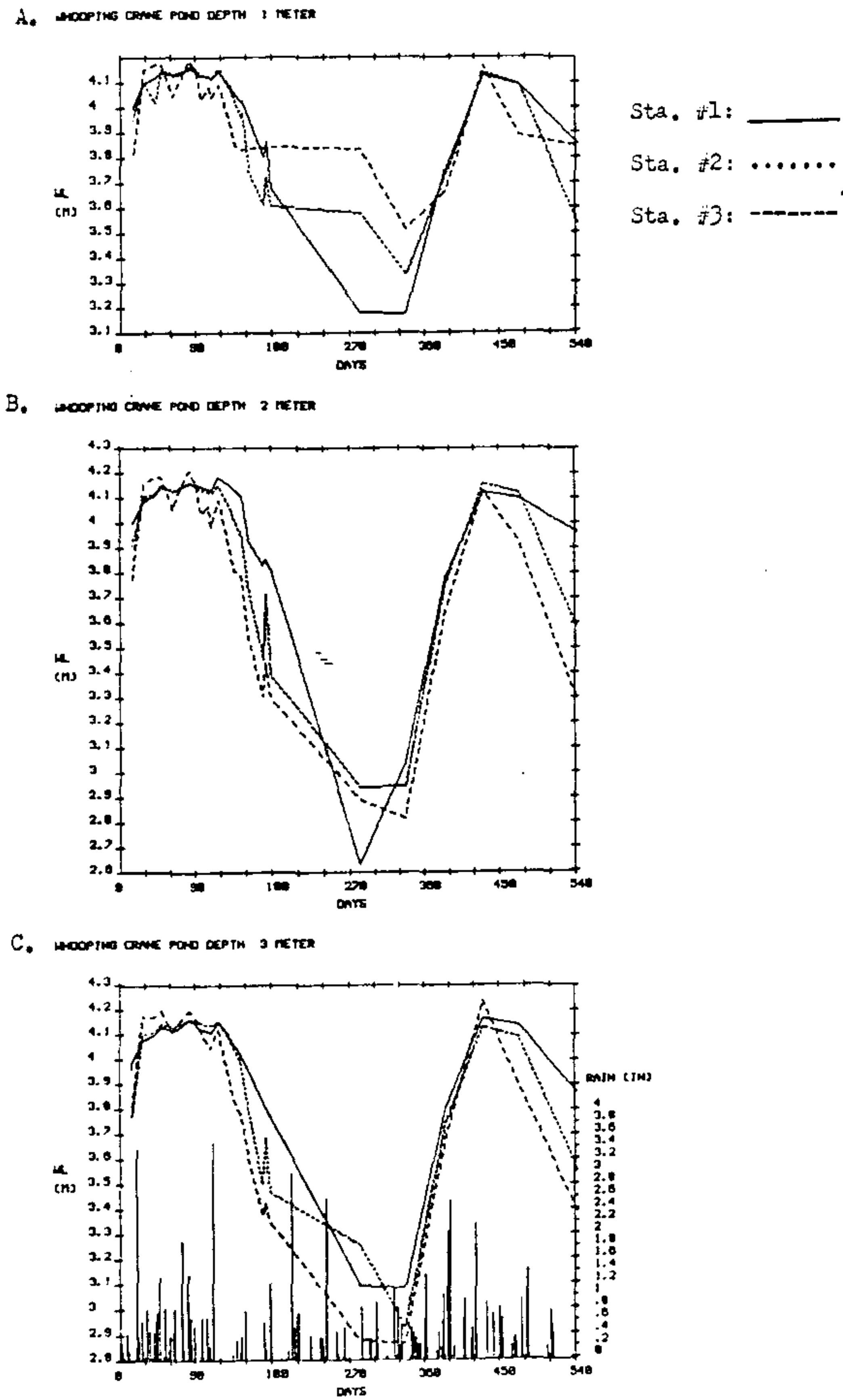


Figure 6. Horizontal gradients of water level versus time at Whooping Crane Pond.

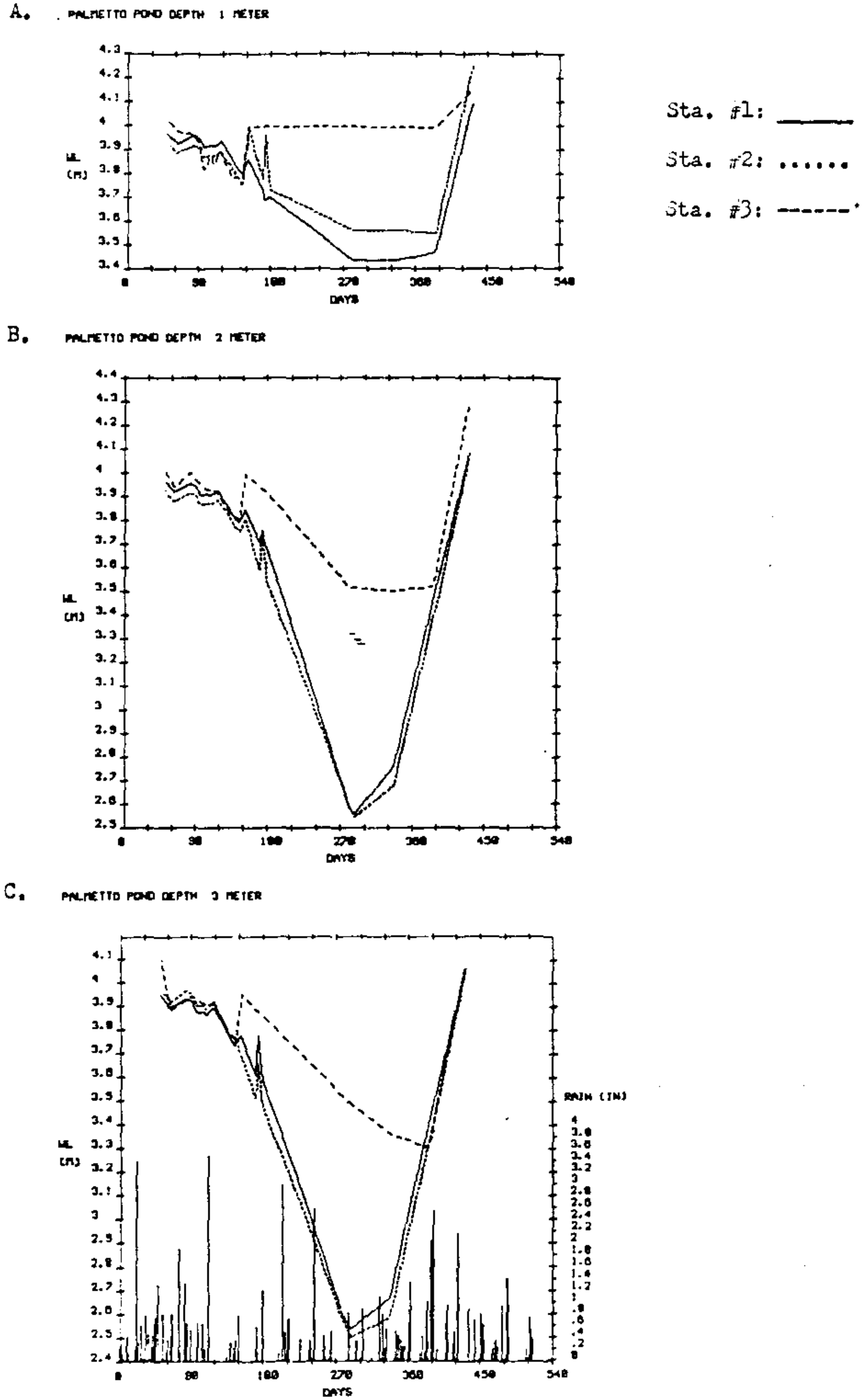


Figure 7. Horizontal gradients of water level versus time at Palmetto Pond.

with the interpretations at Whooping Crane Pond, we feel that a statement to this effect may be made for wetlands in general on Hilton Head.

Figures 8A-C and 9A-C illustrate the vertical gradients of water levels at Whooping Crane and Palmetto Ponds, respectively. Figure 8A and 8B are peculiar in that they indicate that water should flow from the 1 and 3 meter levels to the 2 meter level. If this isn't impossible, it is certainly unlikely. In the case of 8A, the 2 meter point at day 270 is probably erroneous. Unfortunately, there is no such easy explanation for 8B. Figure 8C indicates that recharge is dominant. A closer look at the date reveals, however, that the 1 meter piezometer data is not always valid due to dry hole conditions part of the time. If the 1 meter data is discounted, conditions appear to be dominantly one of discharge. Figure 9A-C shows that at Palmetto Pond, conditions are dominantly recharge, with or without the 1 meter data.

Interpretation based on vertical gradients appear to be more tenuous than those based on horizontal gradients. The case is not strong, but the evidence appears to be sufficient to suggest that, at times, ground water recharge from the wetlands occurs.

Automatic Water Level Recorder Data

Three automatic water level recorders were provided by the S. C. Water Resources Commission for use in this study. They were deployed at Whooping Crane Pond Site as indicated in Fig. 5. These recorders were battery-driven, punched tape type devices designed to be machine read. Sampling was once per six minutes; hence, a voluminous amount of data was generated. Due to a lack of appropriate facilities, the tapes were read manually (visually), a most time-consuming and tedious job of deciphering holes punched in paper.

Recorder #1 was installed at Station #1out in the pond (Fig. 5). It operated continuously from March to June 8, 1983, at which time it malfunctioned. This was not discovered until October 1983, because of the lapse in project funding from July through September. Parts from recorder #3 were used in an attempt to bring #1 back on line, but only intermittent results were obtained. The data from #1 is shown in Fig. 10. The sawtooth shape of the curve results from sharp rises

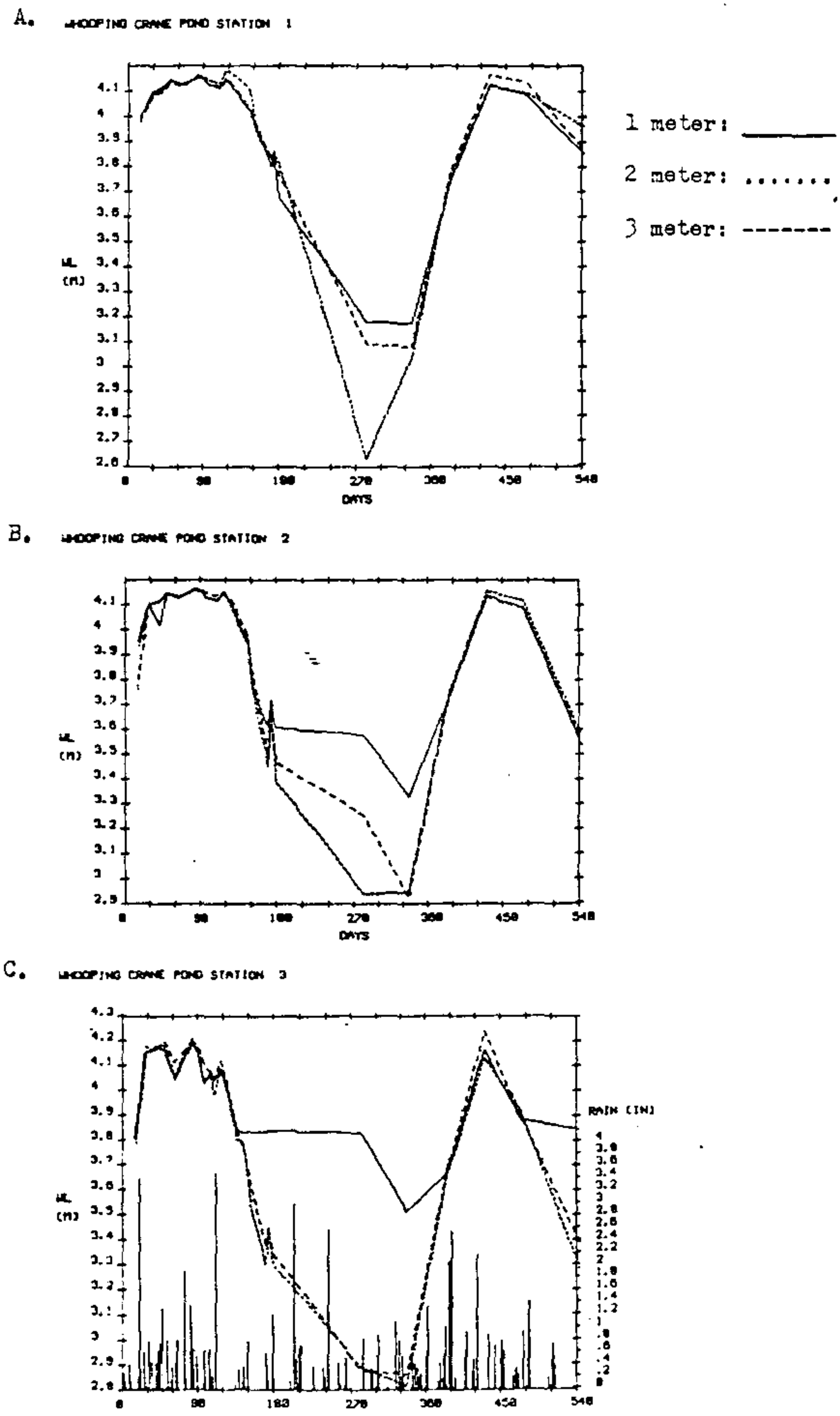


Figure 8. Vertical gradients of water level versus time at Whooping Crane Pond.

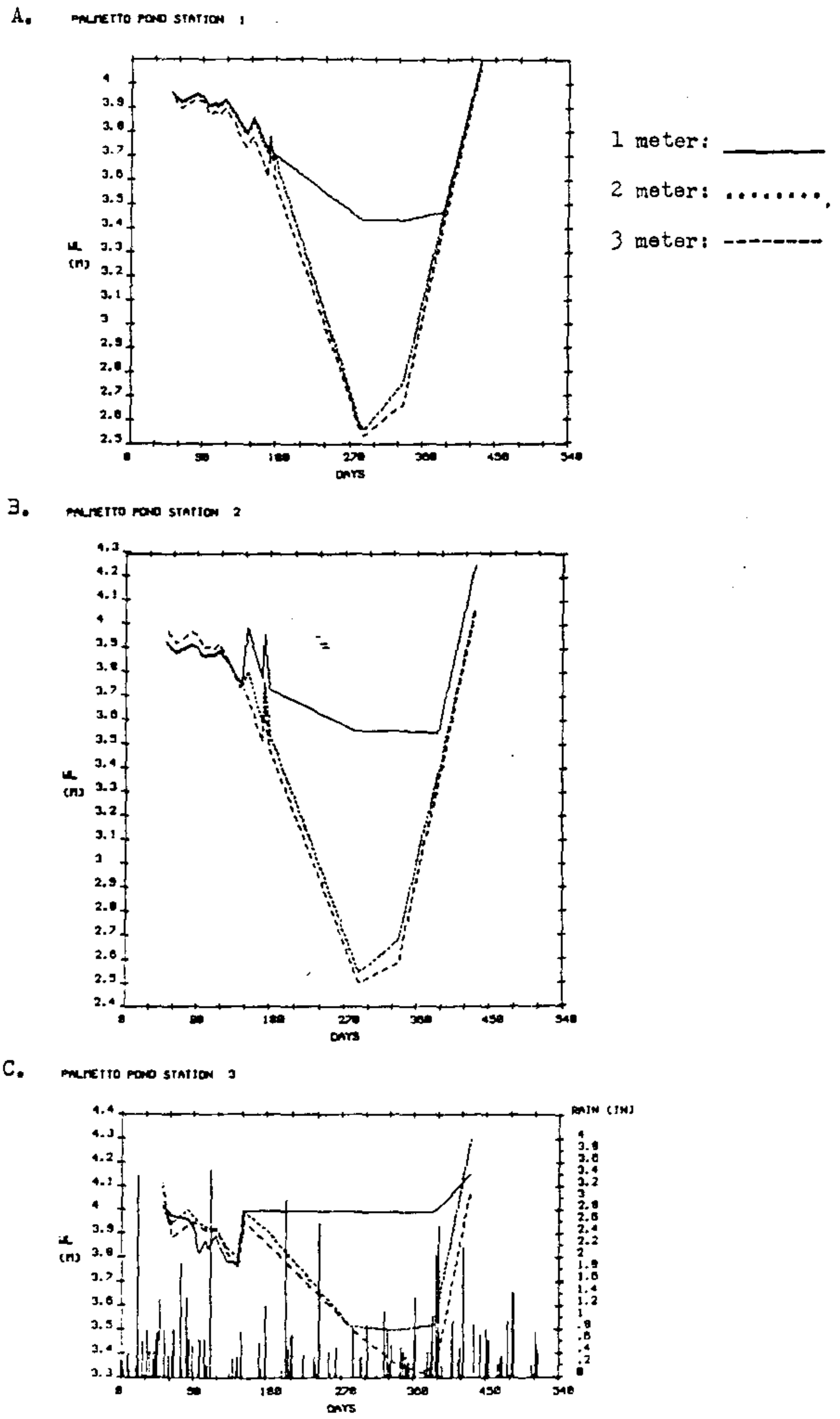


Figure 9. Vertical gradients of water level versus time at Palmetto Pond.

due to rain followed by slow decline due to evapotranspiration and infiltration. It will be seen that the former becomes extremely important in the spring. Note that mild drought conditions existed during the spring and early summer (days 100-200).

A more complete record was obtained from Recorder #2 (Fig. 11), before it failed on April 20, 1984. The 13 months of continuous record provide a good illustration of an annual cycle of water table levels. March, April, and early May, 1983 appear similar to the #1 data. Beginning in mid-May, the curve from #2 begins to show a definite vertical oscillation. Detailed study of the data reveals a night-day variation of up to 30 mm in June and tapering off toward zero toward the end of August. This represents the growing season and results from increased evapotranspiration during the day. There is a slight recovery at night, but a net water loss results. The importance of this process, coupled with deficient rain is dramatically shown by the significant decline in water level from mid-May through August. During the interval August 25 to November 20, the recorder float rested on the bottom of the stilling well hole. That is, the water level declined below the capacity of the recorder to record it. Comparison to manually measured data (Fig. 6), it is extimated that the water level declined at least an additional 0.5 m during that interval.

There is another factor that may be significant with respect to the summertime decline in water levels that causes Whooping Crane Pond to dry up. The pond is the headwater region from a series of artificial ponds that border an adjacent golf course. The irrigation water for the golf course is taken from these ponds or from the water table aquifer, which amounts to the same thing. Spray irrigation is notoriously inefficient with regard to water consumption. A significant part of the water level decline at Whooping Crane Pond may be related to pumping for irrigation.

However, if the above is true, then the water levels at Palmetto Pond must have been similarly extracted because it declined the same order of magnitude during the same period. If it can be demonstrated that Palmetto Pond is essentially a natural system, then this would argue that Whooping Crane Pond was not signficantly affected by artificial factors.

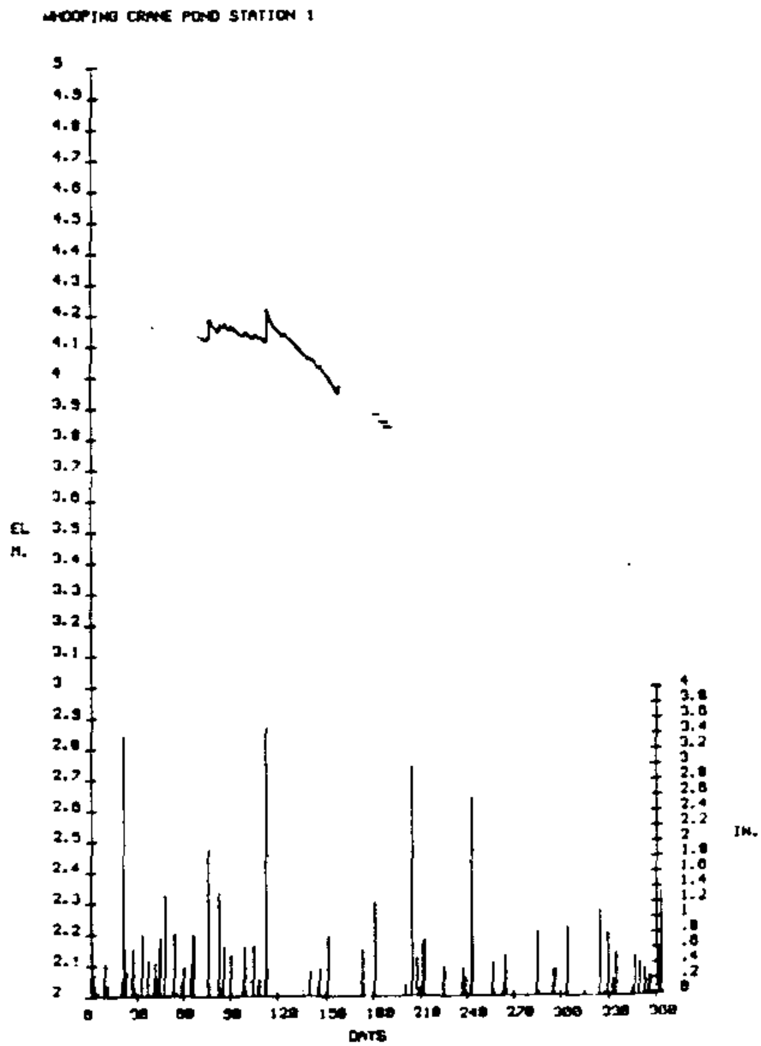


Figure 10. Plot of water level recorder data for pond surface (Station #1) at Whooping Crane Pond.

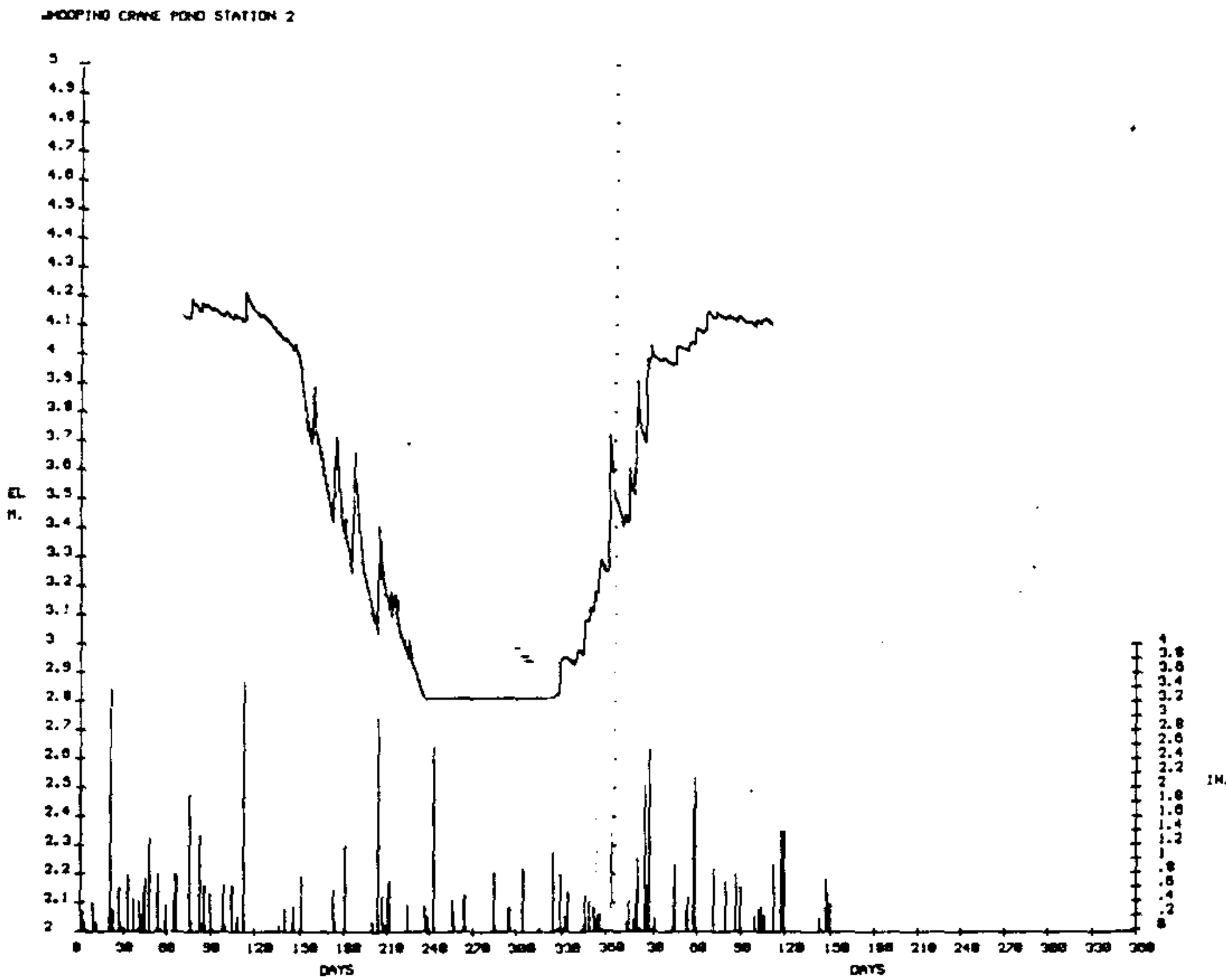


Figure 11. Plot of water level recorder data for water table (Station #2) at Whooping Crane Pond.

Recorder #3 (Fig. 12) was installed on the deep well near Whooping Crane Pond. Continuous data from the interval from March 10 to October 9, 1983 was recorded; however, due to the complicated nature of the data as a result of tidal oscillations, only a few months of data were diciphered. These results do not bear directly on the question of recharge by wetlands. They are of related interest, however, in that they show similar declines in the spring, and even appear to respond to heavy rainfalls (a suggestion of local recharge). This data will be analyzed further at such time that we can manage to get the tapes machine read.

PRECIPITATION AND EVAPOTRANSPIRATION EFFECTS

The causal ~~casual~~ relationship between water levels and rainfall is obvious on the data plots. A heavy rainfall generates an immediate rise in water level in the pond, the water table, and possibly even in the deep limestone aquifer.

From January through April, 1983, rainfall was unusually heavy (Fig. 13), averaging nearly twice the normal average amount for the period. The following four months saw less than half the normal average of rain. The summer months are generally a period of high rainfall, whereas the summer months of 1983 was one of low rainfall. September and October, 1983, were average, but the following 6 months (November 1983-April. 1984) experienced above average rainfall amounts (similar to the previous year). May and June 1984, are again below normal averages indicating that the summer of 1984 may follow the same rainfall pattern as 1983. This situation is unfortunate because the recent trend toward dry summers causes a shortage of water at precisely the time when it is most needed by plants for growth (and, of course, by humans, as well). As long as these rainfall patterns continue, the wetlands can be expected to dry up each summer. This appears to be a normal natural process, though it is aggravated by additional human consumption.

Evaporation is related to temperature; hence, there tends to be an increased water loss due to this cause in the late spring, summer, and early fall. In 1983 and 1984, this coincided with periods of light rainfall, which augmented the decline of water levels. Transpiration results from water use by growing plants. This is also a late spring and summer phenomenon and has recently been using water at a time when

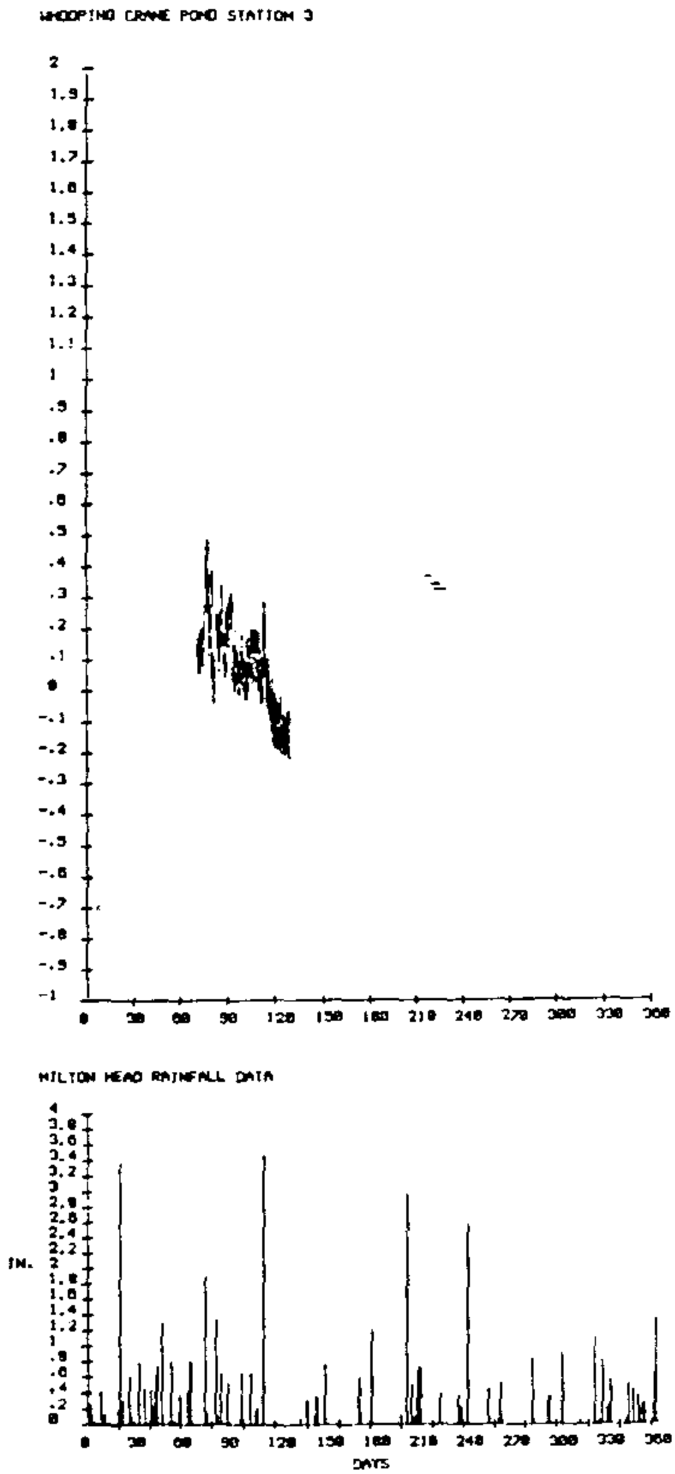


Figure 12. Plot of water level recorder data from deep well (Station #3) at Whooping Crane Pond.

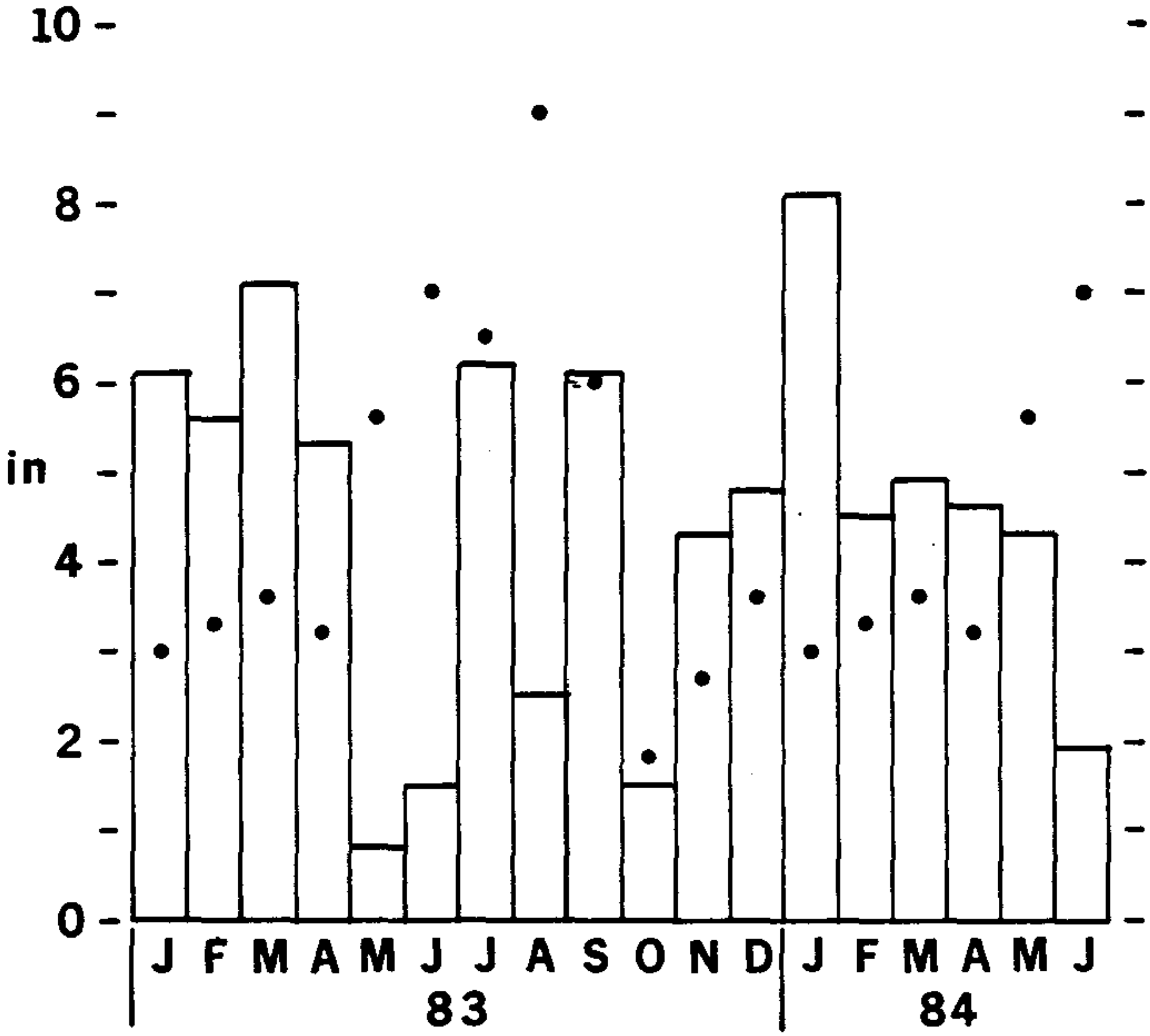


Figure 13. Rainfall distribution during study period at Hilton Head (Honey Horn Plantation). Circles represent average monthly amounts.

it was scarce. The relative importance of evaporation versus transpiration in water consumption is difficult to evaluate. Since the two generally occur simultaneously, they are combined as evapotranspiration. The extent to which the water levels decline at Hilton Head has been due to evapotranspiration versus below average rainfall cannot be evaluated from the data collected by this study. Continuous water table recordings over several years with varying rainfall trends are needed for such an evaluation.

A detailed study of January-April, 1983 indicates that local recharge may be related to these evapotranspiration/precipitation relationships. One can compute the average rainfall per day since the previous set of readings and compare this to the slope of the water table. In the instances when recharge from the pond are indicated, rainfall rates for the previous two weeks was on the order of 0.1" per day. In the other instances when discharge to the pond is indicated, rainfall rates averaged about 0.3" per day. That is, with higher rates of rainfall, percolation into the ground causes the water table to rise proportionately higher than the pond surface rises, thus a pondward slope to the water table surface is developed. Following periods of lower rainfall rates, the water table declines to a level below that of the pond surface. As evaporation would not be greater from the water table surface than from the pond surface, transpiration must be the cause, even though it is relatively low at this time of year (January - March). The ground cover vegetation is dominately diciduous and is probably not significant. The canopy, however, consists of evergreen pines that are apparently using significant quantities of water even during the winter.

After April 1, the recharge role of the pond becomes even more pronounced. Though we might expect an increase in evaporation from the pond surface, there is apparently an even greater increase in transpiration which lowers the water table beneath the upland. That is, due to the onset of the growing season, the increase in the rate of transpiration in the upland in greater than that of the rate of pond evaporation. Total evapotranspiration rate during the growing season is 2 to 3 times that of the dormant season (Linsley, et al, 1949).

CONCLUSIONS

There are strong indications that, at times, the fresh water wetlands on Hilton Head Island act to recharge the water table aquifer. This conclusion is based mainly on the slope of the water table and on the horizontal gradient of potentiometric heads measured in the various piezometers. It is also indicated by vertical pressure gradients at individual stations. Recharge appears to occur episodically and other times are characterized by discharge to the pond.

These conclusions are based on data representing 13 months of measurements. The sampling interval was unusually rainy in the winter and dry in the summer. The results of the study to date are, therefore, biased towards these weather conditions and will probably be altered somewhat as additional data representing other weather conditions and time of year are considered.

RECOMMENDATIONS

It is recommended that a limited data collection process be continued on a permanent basis. This would provide a data base of more valid statistical value than that which presently exists.

This would consist of automatic recorders being maintained on the pond (#1) and at near the edge of the pond #2). It is proposed that these recorders sample hourly and be maintained by monthly visits. The S. C. Water Resources Commission would appear to be the appropriate agency to perform this task. The present author would be willing to perform the data analysis and develop~~e~~ a more complete model of the water table aquifer system at Hilton Head.

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